Iridium Electrodes Increase Spark Plug Life

RESISTANCE TO ATTACK BY LEAD COMPOUNDS

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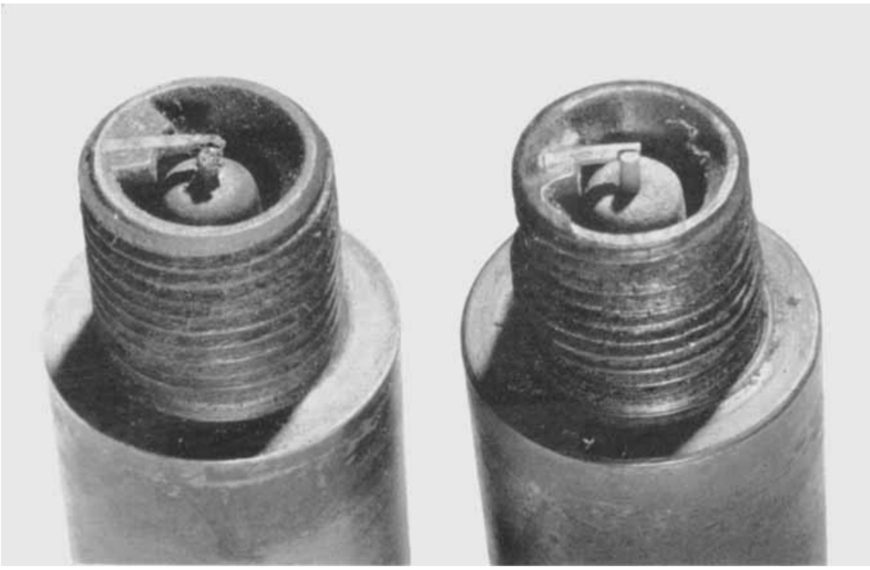
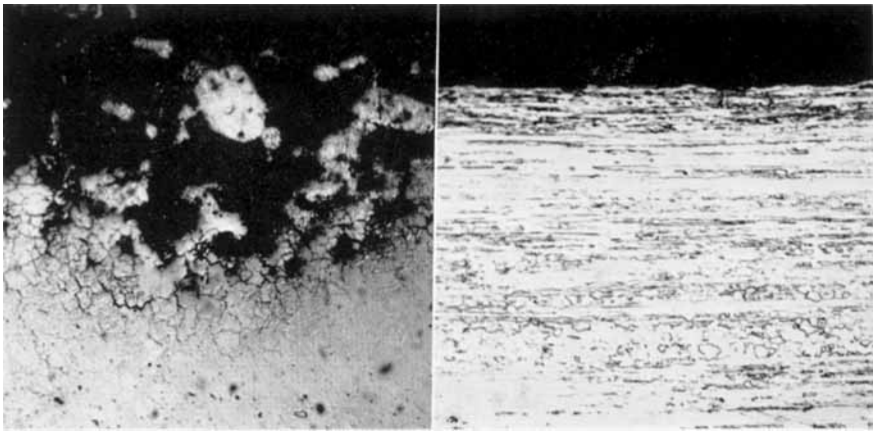
Even in the jet age in which we are now living, the number of aircraft driven by piston engines remains very high, and helicopters and freight aircraft will continue to use these engines for a considerable time.

Since the early years of the last war, spark plugs in aero engines have been fitted with electrodes in a tungsten-platinum alloy which, although ideal in all other respects, suffers from chemical attack by the lead compounds used in high-octane aviation spirit. The precise mechanism of this attack is not yet fully understood, but the effect appears to be one of intergranular penetration. This seriously reduces the resistance of the platinum alloy to spark erosion, leading to a rapid increase in gap size and to eventual failure of the plug. Apart from the failure of the plugs themselves, related equipment such as magnetos and ignition harnesses can break down under the additional electrical loading imposed on them by excessively large spark plug gaps, and it has therefore been essential to rate plug life very conservatively and of course to enforce rigid inspection and maintenance at frequent intervals in order to



On the left is a K.L.G. tungsten-platinum plug after 52 hours in a Bristol Centaurus engine. It already shows the onset of spark erosion from lead attack. The plug on the right is one of the new K.L.G. iridium plugs removed after 925 hours in the same engine. As can be seen, the plug was not cleaned or serviced before the photograph was taken.



Photomicrographs (×120) of spark plug electrodes after 65 hours running in a single cylinder engine test by Bristol Siddeley Engines Ltd. The tungsten-platinum electrode (left) shows severe lead attack; the iridium electrode (right) is unattacked.

ensure safe engine performance. During recent years, this problem has emerged as the major outstanding factor affecting aircraft sparking plugs, despite the investigation of a number of alternative platinum alloys. It was then suggested that the problem might be capable of solution if it were possible to use iridium as the electrode material, since this metal is immune from attack by lead. Now iridium, one of the platinum group of metals, is characterised by high hardness and by quite exceptional difficulty in fabrication. Small quantities of iridium strip and wire had been produced in laboratory conditions, but for all practical purposes the metal had been regarded as brittle and non-ductile.

Production of Ductile Iridium

Early trials with iridium electrodes showed some promise, but its brittleness made production and assembly of the electrodes very difficult and it was clear that a ductile form of iridium was essential to the successful adoption of this metal for plug electrodes. Johnson Matthey therefore began an investigation of possible methods of producing iridium in wire form and, early in 1961, were successful in developing a process of working the metal at very high temperatures to yield both round and square wire having a fibrous structure and good ductility. This material, known as SD Iridium, has now been made available on a quantity basis.

From the earliest days of this development the fullest collaboration was received from Bristol Siddeley Engines Limited, who conducted a number of exhaustive single-cylinder and main engine tests on plugs fitted with SD Iridium electrodes, followed by flight trials in various types of aircraft. In one single-cylinder test a plug life of no less than 1,014 hours was recorded. During this time 22,388 gallons of high octane fuel were used, containing 729 lb of tetraethyl lead (468 lb of lead as metal). At the end of the test the plug was still functioning satisfactorily although the electrodes had been worn to the extent of about 50 per cent.

Flight Trials

Flight trials of experimental K.L.G. plugs using iridium electrodes are still in progress and others are planned, but the remarkable results obtained so far indicate that the new electrode material is well on the way to solving the erosion problem and that there is every likelihood of iridium spark plugs superseding the platinum alloy types, even for service conditions of the less severe kind.

For example, severe spark erosion of the

K.L.G. platinum plugs used in the Alvis Leonides Major engine was experienced in Royal Navy Mark 7 helicopters. This trouble was directly attributable to the particularly arduous conditions imposed by "dunking" operations, wherein the engine is run for long periods at maximum power in the hover. Plug life was seldom better than 80 hours.

With the encouragement and active support of the Ministry of Aviation and the Admiralty a trial set of K.L.G. iridium plugs was installed in one of these helicopters and subjected to the same stringent operating conditions. At 300 hours, electrode erosion was negligible on all plugs, and without servicing of any kind they were re-installed for further running. The trials were extended and continued under operational conditions in the Middle and Far East with results just as satisfactory.

As a result of this, K.L.G. iridium plug Type KA.3 is now officially approved by Alvis Limited for the 14-cylinder Leonides Major engine.

In close collaboration with Bristol Siddeley Engines Limited and Aviation Traders (Engineering) Limited of Southend Airport, K.L.G. are currently running flight trials with a set of iridium plugs in each of five Bristol Freighters operating the Channel Air Bridge. These aircraft were chosen because of their especially strenuous service conditions, involving frequent engine starting, idling, taxiing, maximum power take-offs and climb-outs from congested areas. The platinum plugs for these engines had an average servicing life of 250 hours, but cases of unscheduled removal were quite common.

Despite the operating conditions no troubles whatsoever have been experienced with the new plugs and there is a marked increase in serviceability, ranging from over 600 to over 1,000 hours.

The plug has therefore been submitted to the Air Registration Board for standardisation at an initial figure of 600 hours, before servicing, and has been approved for trial extensions to 1,000 hours.

Similar trials of K.L.G. iridium plugs are under way in a number of RAF aircraft types including Avro Shackleton Mark 3 (Rolls-Royce Griffon), Blackburn Beverley (Bristol Centaurus), and Hastings, Varsity and Valetta (all Bristol Hercules). One other civil operator BKS Air Transport Limited, are carrying out trials in Ambassador Aircraft (Bristol Centaurus). All exhibit the same remarkably successful results.

It is true to say that the ultimate life of an iridium electrode plug is not yet known under service conditions (as distinct from rig conditions) and substantial further running time will have to be achieved in service before this is known.

The successful results so far obtained with iridium electrodes in aero engine spark plugs indicate that plugs of this type may well find applications in the automobile field before very long.

Ruthenium Catalyst for Paraffin Wax Synthesis

LIQUID PHASE HYDROGENATION OF CARBON MONOXIDE

The production of high melting point hydrocarbons by reacting carbon monoxide with hydrogen over a suitable catalyst has long been known to be a possible route to paraffin wax and was first of course proposed by Fischer and Tropsch.

In the past few years some work has been carried out on this reaction by H. Kölbel and K. K. Bhattacharyya (*Plat. Metals Rev.*, 1959, **3**, 59) and a further paper by these workers, together with W. H. E. Müller, has recently been published (*Angew. Chem.*, 1962, **74**, (2), 88).

It is shown in this paper that straight chain paraffins with melting points up to 130°C may be prepared by leading carbon monoxide through a suspension of finely divided ruthenium in water, at pressures of over fifty atmospheres and at temperatures between 150 and 260°C. The mean molecular weight of the product increases with the pressure and falls with increasing temperature.